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ABSTRACT

Results of a study that examined entry competency levels of 1,511 students enrolled in 12 sections of introductory biology at Texas A&M University are reported. A pretest was developed and administered to students which tested basic competencies over nine concept areas considered prerequisite to the introductory biology course. A questionnaire was also administered to collect demographic data on students' sex, course background, intended college major, attitude toward high school biology, and reason for taking the course. The conclusions are that: (1) freshmen, sophomores, juniors and seniors began the course with the same entering competency levels; (2) the number of college chemistry courses students had made no difference in pretest scores; and (3) students who indicated they enjoyed biology in high school received a significantly higher pretest score than those who did not enjoy biology or had no feelings toward high school biology. (Author/CS)

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A Diagnostic Evaluation of the
Entering Competency Levels of

University Introductory Biology Students

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Much has been written concerning curriculum development and instructional design for large university introductory biology classes. However, little is known of the entering competency levels of these students. Such knowledge could be of importance to those responsible for teaching and coordinating introductory science courses. The purpose of this study was to investigate the entering competency levels of students in a university introductory biology course. Statistical comparisons were made between selected subgroups within the total population. The comparisons were based upon the results of a pretest which measures general knowledge that was considered prerequisite to the introductory biology course (Soucek, 1979). A questionnaire was given to identify the subgroups within the population. Though one must be careful in generalizing these results, they do provide insights and may stimulate further studies.

Method

Subjects

The sample consisted of 1,511 students enrolled in 12 sections of introductory biology at Texas A&M University. Texas A&M is a

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coeducational land-grant institution with an enrollment exceeding 30,000. Eleven hundred eighteen students responded to the questionnaire. The enrollment in each section ranged from approximately 60 to 300 students.

Development of the Pretest

Nine important concept areas considered prerequisite to the introductory biology course were identified. These concept areas were based upon the course syllabus. A table of specifications was developed to assure content validity (Bloom, Hastings, and Madaus, 1971). Appropriate test items were then written. The pretest consisted of ninety items, ten items per concept area. The nine concept areas included in the pretest were: chemistry, cell physiology and structure, photosynthesis, respiration, cellular reproduction, genetics and inheritance, animal survey, evolution, and ecology. The test, therefore, consisted of a battery of nine ten-item subtests.

Three pilot tests were given. Items selected from these three tests were used to develop the pretest employed as the main study. The test refinement procedure used to select items consisted of four steps: (1) items were removed which discriminated negatively, (2) items which were found to be extremely difficult were removed (Gronlund, 1977) or modified, (3) the remaining items were reviewed to assure that the questions were an adequate sample of learning which was considered prerequisite to the course, and (4) the test items were arranged in increasing order of difficulty. The pretest was developed according to specifications suggested by Gronlund (1977) for the construction of objective tests of knowledge.

A generalization of the Kuder-Richardson Formula 20 for dichotomous items was used to determine test reliability (Veldman, 1967). The reliability of the pretest used in the main study was .88.

Determination of Entering Competency Levels

All tests were given the first day of class. The time allowed to take the main study pretest was 45 to 50 minutes.

A questionnaire was used to collect demographic data and was administered separately. The questionnaire was designed to gather information regarding students' sex, course background, intended major college, attitude, and reason for taking the course. Each student's questionnaire response was matched with his pretest score to yield subgroup mean pretest scores. This analysis was done using SAS 76 (Barr, Goodnight, Sall, & Hellwig, 1976). The pretest scores indicated student entering competency levels with respect to the demographic variables of the questionnaire.

Analysis of variance and a two-tailed t-test for unequal variance and number of subjects were used to identify differences in means. If the analysis of variance procedure revealed a difference in means, Fisher's Least Significant Difference procedure (Fisher's LSD) was used to identify the means that were significantly different. The alpha level for all these tests was .05. These results revealed entering characteristics of the sample population and patterns of pretest scores.

Results

The total pretest mean was 46.47 with a standard deviation of 12.17. The pretest means and standard deviations for each concept

area (ten items per concept area) are shown in Table 1.

TABLE 1
Concept Area Means and Standard Deviations

Concept Area	Mean	Standard Deviation
Chemistry	5.23	1.88
Cell Physiology and Structure	5.90	2.16
Photosynthesis	4.74	2.16
Respiration	4.39	1.95
Cellular Reproduction	5.68	1.69
Genetics and Inheritance	4.69	2.01
Animal Survey	5.50	1.93
Evolution	4.23	1.64
Ecology	6.10	2.11

It was found that males received significantly higher pretest scores than females. Questionnaire results showed that 57.2 percent of the students had not taken a high school biology course for three years or more or had not taken one at all. Table 2 illustrates that the number of years which had passed since the students took high school biology made a significant difference in pretest score. Using Fisher's LSD procedure, it was found that those who had taken high school biology one or two years previous to the university biology course received significantly higher pretest scores than those who

TABLE 2

Analysis of Variance for Years Passed
Since High School Biology

Source	SS	df	MS	F
Between	14044.12	3	4681.37	35.09*
Error	147020.39	1102	133.41	

*Significant at .05 level.

had taken biology three or more years previous to the university biology course or who had not taken any biology courses in high school]. Students indicated that they had taken high school biology one year previous to the university biology course received the highest mean pretest score (53.35).

Table 3 indicates that student classification as a freshman, sophomore, junior, or senior made no difference in pretest scores. Also, as shown in Table 4, the number of semesters of college chemistry that the student had completed made no significant difference in pretest scores.

TABLE 3

Analysis of Variance for
Student Classification

Source	SS	df	MS	F
Between	638.27	3	212.76	1.51*
Error	153956	1094	140.73	

*Not significant at .05 level.

TABLE 4

Analysis of Variance for Previous College
Chemistry Courses Completed

Source	SS	df	MS	F
Between	163.91	4	40.98	.280*
Error	163236.52	1117	146.14	

*Not significant at .05 level

Table 5 lists the mean and standard deviation of pretest scores with respect to major college. There was no significant difference between pretest scores of students intending to pursue programs in the Colleges of Education, Liberal Arts, and Architecture and Environmental Design. There was no difference in pretest scores between the College of Science students and the College of Architecture and Environmental Design students. There was also no difference in pretest scores between the College of Science students and the Colleges of Agriculture and Geoscience students.

Significantly higher pretest scores were found to exist for the group of students intending to major in the Colleges of Agriculture and Geosciences when compared to groups of students intending to major in the Colleges of Education, Liberal Arts, and Architecture and Environmental Design. Persons planning to major in the College of Science received significantly higher pretest scores when compared to persons planning to major in the Colleges of Education and Liberal Arts.

Students attitude toward high school biology made a significant

TABLE 5

Pretest Mean and Standard Deviation With
Respect to Intended Major College

College	Mean	Standard Deviation
Colleges of Agriculture and Geosciences	49.24	12.03
College of Science	48.14	11.92
Colleges of Architecture and Environmental Design	47.50	13.69
College of Liberal Arts	44.67	10.70
College of Education	38.41	10.00

difference in pretest scores (see Table 6). There was no significant difference between pretest scores for those who indicated that they did not enjoy biology in high school and those who indicated they had neutral feelings. Those who indicated that they enjoyed biology in high school received significantly higher pretest scores than those of the other two groups.

TABLE 6

Analysis of Variance for Attitude
Toward High School Biology

Source	SS	df	MS	F
Between	6846.49	2	3423.25	24.68*
Error	153288.81	1105	138.72	

*Significant at the .05 level.

The final characteristic investigated concerned the effects of students' reasons for taking the introductory biology course. The reason the students' gave for taking course made a significant difference in pretest scores (see Table 7). There was no significant difference between pretest scores for those who were taking biology as a requirement for their major program and those who were taking biology to fulfill the university science requirement. Those who indicated that they simply felt like taking the course scored significantly higher on the pretest than the other two groups.

TABLE 7

Analysis of Variance for Students' Reason for
Taking University Introductory Biology

Source	SS	df	MS	F
Between	2141.91	2	1070.96	7.51*
Error	159664.08	1105	142.55	

*Significant at .05 level.

Conclusions

Several important findings emerge from this study. The first major conclusion is that freshman, sophomores, juniors and seniors began the course with the same entering competency levels. This reveals that students from all classes were not significantly different in terms of their background at the beginning of the introductory biology course. Another conclusion drawn from this study is that the number of college chemistry courses the students had completed made no difference in pretest scores. There was, for

example, no significant difference in pretest scores between those who had taken no college chemistry and those who had taken two semesters of college chemistry. This indicates that students who had taken college chemistry tend to be no better prepared for college introductory biology than those who had taken no college chemistry. Students who indicated that they had taken high school biology one or two years ago were better prepared for introductory biology when compared to those who had taken high school biology three years ago, four years ago or to those who had not taken high school biology.

Another important conclusion relates to the students' attitudes toward their studies. This investigation demonstrated that students who indicated they enjoyed biology in high school received a significantly higher pretest score than those who did not enjoy biology or had no feelings toward high school biology. This indicates that those who enjoyed high school biology had an improved prerequisite knowledge as compared to students in the other two groups. This finding may hold implications for the design of the instructional program in university introductory biology courses. If instructors in these introductory biology classes work to develop positive attitudes in the students toward these courses, the students' level of achievement may increase. These students, learning more in the introductory course, may be better prepared to deal with the content of more advanced courses. Further, it is possible that these students will develop a positive attitude toward their future studies in more advanced courses.

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